DOCUMENT RESUME

ED 263 167 TM 850 652

AUTHOR Lane, David S., Jr.; Newman, Dianna L.
TITLE Investigating the Relationship between Field Independence-Dependence and Conditional Reasoning Performance within an Effective Instructional System.
PUB DATE [85]
NOTE 21p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Analysis of Covariance; Cognitive Processes; *Cognitive Restructuring; *Field Dependence Independence; Higher Education; *Intervention; *Logical Thinking; *Perception Tests; Retention (Psychology); Undergraduate Students
IDENTIFIERS Group Embedded Figures Test (Witkin); Syllogisms

ABSTRACT

College undergraduates (n=44) were given a measure of field independence-dependence prior to receiving instruction in conditional reasoning. Instruction incorporated various aspects of an earlier effective instructional system that was adapted for present learners and was incorporated into a larger, more typical classroom group. Results indicated conditional reasoning performance increased following instruction and was maintained after two weeks. There was a positive but non-significant relationship between field independence-dependence and conditional reasoning. However, examination of the beta weight for covariances (B=.23) does indicate a positive relationship between the two variables. This suggests that lack of support in this study may be because of statistical power. It is possible that with a larger sample or more extensive tests of conditional reasoning and field independence-dependence a significant relationship would be found. It is also possible that due to the apparent difficulty of conditional reasoning, learners fail to see or use their respective field independent-dependent strategy when dealing with the syllogism used. (Author/PN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED263167

Investigating the relationship between field independence-dependence and conditional reasoning performance within an effective instructional system

David S. Lane, Jr.

Dianna L. Newman

Oklahoma State University

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Lane, D.S.
Newman, D.L.

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Running Head: Conditional Reasoning Performance

TM 850 052

Abstract

College subjects were given a measure of field independence-dependence prior to receiving instruction in conditional reasoning. Instruction incorporated various aspects of an earlier effective instructional system that was adapted for present learners and was incorporated into a larger-group, more typical classroom. Results indicated conditional reasoning performance increased following instruction and was maintained after two weeks. There was a positive but non-significant relationship between field independence-dependence and conditional reasoning.

Investigating the Relationship between Field Independence/Dependence and Conditional Reasoning Performance within an Effective Instructional system

A comprehensive review by Lane (1985) revealed over 100 studies which attempted, through various methods, to improve logical reasoning performance. Most of these studies reported performance improvement following instruction yet overwhelmingly supported the difficulty of logical reasoning for both children and adults. This difficulty of logical reasoning appears to make instructional design difficult and performance increases elusive in many cases.

Particularly difficult for most subjects to learn is the conditional form of logical reasoning. Conditional reasoning is sentence reasoning typically stated in a "If p ... then q" format. A typical conditional reasoning problem states one of four possible first premises, follows it with one of four second premises affirming or denying part of the first premise and then asks the learner to make a conclusion. Several studies indicate that the conditional form of reasoning is the most resisitant to instructional benefits (e.g., Wason, 1968; Taplin, 1971; Lunzer, Harrison, & Davey, 1972). Studies by Ennis & Paulus (1965), Staudenmayer & Bourne (1977), and Shigaki & Wolf (1982) demonstrated that subjects could readily learn other forms of logical reasoning but not the conditional form.

The literature does not suggest that conditional reasoning is unable to be learned, only that it may require unique forms of instruction. Recent studies by Lane, Fletcher, & Fletcher (1983), Lane (1983), and Lane (In press) have demonstrated the effectiveness of one particular instructional

method on children's conditional reasoning abilities. The basic method in these studies included a three-dimensional logic board on which the children manipulated geometric blocks to answer verbalized questions on conditional syllogisms. The procedure utilized a guided-discovery technique where learners would "discover" syllogisms inherent in the logic board configuration. Further refinements of the method indicated that the basic materials worked well when children were only given two dimensional pictures representing the logic board configurations, as long as the guided-discovery procedure was present. Results in all three studies included retention of the instructional performance gains for up to two weeks.

The studies by Lane always involved preadolescent children and always incorporated small group instruction. Typically, if this type of conditional reasoning instruction is to be incorporated into the regular classroom, it must be effective with larger groups and a wider range of ages. Consequently, one purpose of this study was to test the applicability and the effectiveness of the basic method used by Lane as adapted to older learners in a more typical classroom setting.

One of the goals of conditional reasoning research must be to investigate the inherent difficulty of the conditional syllogism. The literature suggests that reasoning ability is related to many organismic variables (eg. sex, intelligence) that the learner brings to the instructional setting. A special type of organismic variable is learner's cognitive strategies. Previous research has shown cognitive strategies to be related to better reasoning performance (Kodroff & Roberge, 1975; Paris & Upton, 1976). Cognitive styles - individual ways learners use to represent knowledge and to form cognitions - could be thought of as one type of cognitive strategy. Consequently, another purpose of this study was to

ascertain the relationship between conditional reasoning performance and a measure of cognitive style, namely field independence and dependence. It was hypothesized that conditional reasoning performance might be related to the way a person views the syllogistic situation which appears similar to the global or analytic interpretation of field independence-dependence performance.

METHOD

Subjects. Participants were junior and senior undergraduates enrolled in an upper level educational psychology course required for teacher certification. Two classes were chosen out of the eight sections offered during the semester. One class was assigned as the instructional group, this group received two 50-minute periods of instruction on conditional reasoning. In the instructional group, there were ten men and ten women. The second class was designated as the non-instructional group and received no special conditional reasoning instruction. In the non-instructional group, there were three men and 21 women.

Instructional materials. Materials used for the instructional group were developed and adapted from materials used by Lane (in press). Since the earlier study used only 4-6 students at one time and the present study instructed 25+ students, some adjustments were made to allow group administration. However, care was taken to make the two types of materials parallel each other as much as possible.

Each student in the instructional group received a packet of eight 21.5 X 28 cm pieces of white paper. On each paper was drawn a black line representation of a conditional syllogism. Each representation incorporated the Venn diagram format with two overlapping 16 cm diameter circles. The pictures were used to illustrate the four main

conditional reasoning arguments. The four main arguments and their corresponding syllogisms illustrated in the pictures were:

If p, then q - If it has stripes, then it is a circle

If not p, then q - If it does not have X's on it, then it is a rectangle.

If p, then not q - If it is a triangle, then it is not dotted

If not p, then not q - If it is not striped, then it is not square

There were two pictures drawn for each of the four syllogisms above. Because the the instructional group was to "discover" the syllogism illustrated in the picture, the syllogism was not printed on each paper. Instead, the pictures were drawn to facilitate discovery of the inherent syllogistic pattern.

Each picture had the two intersecting circles typical of the Venn Diagram. On the top of one circle was printed either the antecedent denied term or the antecedent affirmed term. Thus for the first syllogism above, "If it has stripes, then it is a circle,"one circle had either "stripes" or "not striped" printed on top while the other circle had either "circle" or "not circle" printed on top of it. The decision as to which term was to be printed was determined randomly.

Squares, triangles, circles, and rectangles were used to illustrate the syllogism. These figures could be striped, checkered, "x'ed", plain or dotted. The incorporation of this second element was to mirror the second dimension of color used in the original Lane materials. Color was not possible in these materials.

Each picture had a different number of geometric figures with different patterns; however, only figures and patterns were used which

correctly illustrated the syllogism inherent in the picture. Figures were drawn in their correct location on the picture either in one of the two circles, the intersection or outside the circle. Correct placement depended on the syllogism being illustrated and the antecedent and consequent terms written on top of the circles. A representative picture is shown in Figure 1.

Insert Figure 1 here

Since there were two pictures for each of the four main syllogistic arguments, a second picture was then drawn. This second picture contained the same number and patterns of geometric figures as the first pictures for the syllogism. The difference between the two pictures for each syllogism is that one or both of the labels on top of the pictures were changed; this alteration required the placement of the figures in different areas of the drawing.

Thus, each of the four main syllogism had two pictures. Each set of two pictures utilized the same figures, Venn diagram format and patterns on the figures. Only the labels on the circle were changed to make for a different arrangement of the figures illustrating the syllogism.

The packets were arranged so that the first two pictures were for the syllogism "If it has stripes, then it is a circle" and the second two pictures illustrated the syllogism "If it is not striped, then it is not square." The third set of two pictures were drawn for the syllogism "If it does not have X's on it, then it is a rectangle" while the fourth set illustrated the syllogism "If it is a triangle, then it is not dotted." All eight pictures were stapled together. Eight identical overlays to be used with an overhead

projector by the instructor were also made.

Tests. A pretest, posttest, and retention test were developed to measure the students' conditional reasoning performance. Each of the three tests was a 32 item instrument incorporating the 16 different conditional syllogisms which are derived from matching the four first premises with the four second premises. There were two items for each of the 16 problems; one item incorporated colors and geometric figures, the other item incorporated nonsensical, unfamiliar relationships. Examples of test items for the problem "If p, then not q; q" would be

If it is red, then it is not a rectangle

If is not a rectangle

Therefore: a) it is red

b) it is not red

c) NDC

and

If horses are green, then they do not have two tails

They do not have two tails

Therefore: a) horses are green

b) horses are not green

c) NDC

The order of the items was randomly determined. All three tests were similar to those used in earlier studies (Lane, 1983; Lane, in press; Lane, Fletcher, Fletcher, 1983).

The Group Embedded Figures Test (GEFT) (1971) was used to measure field dependence-field independence. Each subject received a booklet with three sections of embedded figures. The task was to find a simple geometric figure embedded or hidden in a more complex figure. The

test was administered according to standardized directions.

Instructional and testing schedule. Students in both groups were given the pretest and the Group Embedded Figures Test on Thursday. The instructional group received instruction on the following Tuesday and Thursday; non-instructional subjects received regular content instruction. The posttest, was administered to both groups on the next Thursday after the pretest; for the instructional group this was immediately following the second day of instruction. The retention test was administered on Thursday two weeks after the posttest (three weeks after the pretest).

Instruction. The following occurred only for the instructional group, non-instructional subjects received no conditional reasoning instruction and simply continued with their normal classroom activities. On the first day of instruction, each subject was given a packet of the eight pictures described above. The class was told that they were going to learn about the type of reasoning dealt with on the pretest, i.e. conditional reasoning. The group was asked to look at the first picture which was also illustrated on a standard classroom screen using an overhead projector.

The class was then asked if they could "discover" or "come up with" a solution or rule using the "If ... then" format which would describe the relationship in the picture. Incorrect responses were acknowledged and then disclaimed through illustration using the picture. Once the correct syllogism was ascertained and mutually agreed upon by a majority of the class, the instructor produced the syllogism on top of the overlay on the screen and individuals were asked to write the syllogism on top of their picture. The instructor did not proceed until all subjects understood (through verbal affirmation) how this syllogism fit or described the picture.

The group was then told that a series of hypothetical figures (squares,

rectangles, etc.) with certain attributes (striped, not dotted, etc.) would be named. The figures were never actually produced. The task was to determine what could be concluded about the item given the syllogism and the picture. One attribute was named for the antecedent and consequent denied or affirmed terms. For the first syllogism "If it has stripes, then it is a circle", the experimenter would say to either an individual or the group, "What could you conclude if I told you this item (not shown) was a circle (or striped or not striped or not a circle)?" Individual students would then volunteer answers. Incorrect ones were quickly ruled out - usually by other members in the group. The first time the situation arose where the hypothetical item could be placed in several areas or no areas or "you could not tell from the information given", the term "No Definite Conclusion" or NDC was introduced and explained. The method proceeded only when everybody understood the right answers. Eight such answers were verbally procurred - two for each antecedent affirmed, antecedent denied, consequent affirmed, and consequent denied term.

Following these eight verbal answers, four written responses were asked for - one for each of the antecedent denied or affirmed and consequent denied or affirmed terms. This written phase was to help rule out the possibility that students were simply acquiesing to other students' verbal responses. Questions were asked for and students were encouraged to admit when they were confused or did not understand. At no time did the instructor proceed until all students were following the sequences.

The group was then asked to flip to the next picture and told to discover a syllogism; students saw that the same syllogism held for the second picture in each set. Eight verbal questions were asked to individual students - two for each consequent and antecedent denied or affirmed

term. The purpose of the second picture in each set was to demonstrate that the patterns in conditional reasoning remain regardless of the patterns in the pictures. Each set of pictures was illustrated in this fashion. Thus each of the 16 syllogistic problems was fully illustrated and demonstrated five times for a total of 80 questions - 64 verbal and 16 written during the first day of instruction. This first day last approximately 50 minutes.

The second day of instruction involved three phases. During phase one, students reviewed two of the picture sets used during the first instruction day. Four questions were asked for each of two pictures. Some of these questions were to the class as a whole, some to individuals. Question and comments were addressed and reviewed. This phase served to refresh students' memories as to the conditional syllogistic patterns.

During phase two, students were asked to make up three nonsensical syllogisms. The only restraints were that the syllogisms be in the "If...Then" format and that one of the syllogisms incorporate the term "not". A typical syllogism was "If it is a dog, then it Eric." Oral questions were asked to individuals on each nonsensical syllogism-two for each of the second premises. Affirmation of the response was received from the rest of the class. Following the oral questions, six questions were asked for which written responses were required. All four second premises were covered at least once. Incorrect responses were explained. Again, any questions or problems were addressed and the experimenter did not proceed until visually or verbally assured that all students were following the procedures.

In the third phase, students were asked eight oral questions. The differences was that students were simply <u>read</u> one of the four syllogism illustrated in the original pictures; the pictures, however, were not used

and there were no other visual prompts. Students thereby heard the syllogism, heard the second premise and then wrote their response. Each of the four first premises used in the pictures was read twice and each of the four second premises was asked twice. This phase was incorporated to help students make more abstract judgements without the use of concrete visual prompts.

The second day of instruction included 42 questions - 28 oral and 14 written and each of the 16 conditional syllogisms was covered at least twice. Instructional time for the second day was approximately 50 minutes.

Results

A 2X3 repeated measures analysis of covariance was used to analyze the data. The factors were Group (Treatment and Control) and Time (Pre Test, Post Test, Retention). The covariate was the score on the GEFT; the dependent variable was number right on the conditional reasoning tests. Means and standard deviations may be found in Table 1; the analysis of covariance is summarized in Table 2. The analysis of covariance indicated that score on the embedded figures test was not a significant covariate ($F=2.37$; $df=1,41$; $p=.132$); therefore, a repeated measures ANOVA was used to examine effect of treatment on conditional reasoning over time. The differences in variability, though increasingly larger for the instructed subjects, were not significant. Examination of the source table indicated a significant ordinal interaction between the variables Group and Time ($F=15.74$; $df=2, 84$; $p<.001$). In looking at the means, it can be seen that the group which received the treatment made greater gains from pretest ($\bar{X}$ = 16.80) to post test ($\bar{X}$ = 22.80) than did the control group (Pre $\bar{X}$ = 15.71;

Post $\bar{X}$ = 16.33). While there was a slight drop in both groups' scores on conditional reasoning after eleven days, the experimental group still maintained a higher score ($\bar{X}$ = 21.15) than did the control group ($\bar{X}$ = 15.83). Eta squared strength of association indicated that seven percent of the differences in conditional reasoning scores were accounted for by the presence of both group membership and time of testing.

Discussion

The usual caveats of quasi-experimental research must be observed in this study. These include use of intact groups and necessary awareness of instructional technique by the instructor. Despite these limitations, there are several conclusions that can be drawn.

This study does not support the use of field independence-dependence as a covariate when studying conditional reasoning. This is interesting because it would appear that both conditional reasoning and field independence-dependence rely on similar types of psychological differentiation. Both tasks require separating parts from wholes and require abstracting various pertinent aspects to solve complex problems. It is possible that field independence-dependence is not related to conditional reasoning performance. However, examination of the beta weight for covariance (B = .23) does indicate a positive relationship between the two variables. This suggests that lack of support in this study may be because of statistical power. It is possible that with a larger sample or more extensive tests of conditional reasoning and field independence/dependence a significant relationship would be found. It is also possible that due to the apparent difficulty of conditional reasoning, learners fail to see or use their respective field independent-dependent strategy when dealing with the

syllogism.

An important finding is continued support for the instruction of conditional reasoning. Those subjects who received what could be considered limited instruction in conditional reasoning not only did better on the posttest but also retained the information for at least two weeks.

The present method was an expansion of an effective instructional system that had previously only been tested with preadolescents. Results indicate the viability of the basic method, using Venn diagram, verbal questioning, and guided discovery techniques, with college-age subjects in a typical classroom setting. These results continue to suggest the effectiveness of limited instruction on improving and maintaining conditional reasoning performance.

Future directions for research include continued investigation of the relationship between various cognitive styles and reasoning and examination of why subjects performance variability continues to be more pronounced following instruction. Another interest is in the instruction of cognitive strategies and the deliberate introduction of the cognitive strategy into the instructional setting.

Table 1

Means and Standard Deviations for Learning

By Group

Experimental		Pre	Post	Follow-up
n=20	X	16.80	22.80	21.15
	S	2.98	4.73	5.13
Control				
n=24	X	15.71	16.33	15.83
	S	1.83	2.08	1.92

Table 2

Analysis of Variance for Group By Time

On Learning

Source	SS	df	ms	F	Eta Squared
Group	602.78	1	602.78	28.44**	.26
Error	890.13	42	21.19		
Time	214.77	2	107.39	19.34**	.09
Group X Time	174.77	2	87.39	15.74**	.07
Error	466.45	84	5.55		

** $p < .001$

References

Ennis, R. H. & Paulus, D. H. (1965). Critical Thinking Readiness in Grades 1-12 (Phase I: Deductive Logic in Adolescence). (U.S. Office of Education Publication No. 1680). Washington, D.C.: U.S. Government Printing Office. (ERIC Document Reproduction Service No. ED 014 765).

Group Embedded Figures Test (1971). Consulting Psychologists Press, Inc.

Kodroff, J. K. & Roberge, J. J. (1975). Developmental analysis of the conditional reasoning abilities of primary-grade children. Developmental Psychology, 11, 21-28.

Lane, D. S., Jr. (1985). Review of pertinent factors in logical reasoning instruction. Manuscript submitted for publication.

Lane, D. S., Jr. (in press). Systematic investigation of critical variables within a conditional reasoning instructional system used with preadolescents. Journal of Early Adolescence.

Lane, D. S., Jr. (1983). Using observational and action instruction to facilitate conditional reasoning performance in early adolescents. Journal of Early Adolescence, 3, 335-348.

Lane, D.S., Fletcher, D. N., & Fletcher, H. J. (1983). Improving conditional syllogism performance of young gifted and normal students with discovery and rule instruction. Journal of Educational Psychology, 75, 441-449.

Lunzer, E. A., Harrison, C., & Davey, M. (1972). The four-card problem and the generality of formal reasoning. Quarterly Journal of Experimental Psychology, 24, 326-339.

Paris, S. G. & Upton, L. R. (1976). Children's memory for inferential relationships in prose. Child Development, 47, 660-668.

Shigaki, I. S. & Wolf, W. (1982). Comparison of class and conditional logic abilities of gifted and normal children. Child Study Journal, 12, 161-170.

Staudenmayer, H. & Bourne, L. E., Jr. (1977). Learning to interpret conditional sentences: A developmental study. Developmental Psychology, 13, 616-623.

Taplin, J. E. (1971). Reasoning with conditional sentences. Journal of Verbal Learning and Verbal Behavior, 10, 219-225.

Wason, P. C. (1968). Reasoning about a rule. The Quarterly Journal of Experimental Psychology, 20, 273-281.

BEST COPY AVAILABLE

Figure 1 -- Representative diagram used with instructional/experimental group illustrating one of the conditional syllogisms.